# Metal-Mediated Assembly of Semiconductor Nanostructure Arrays

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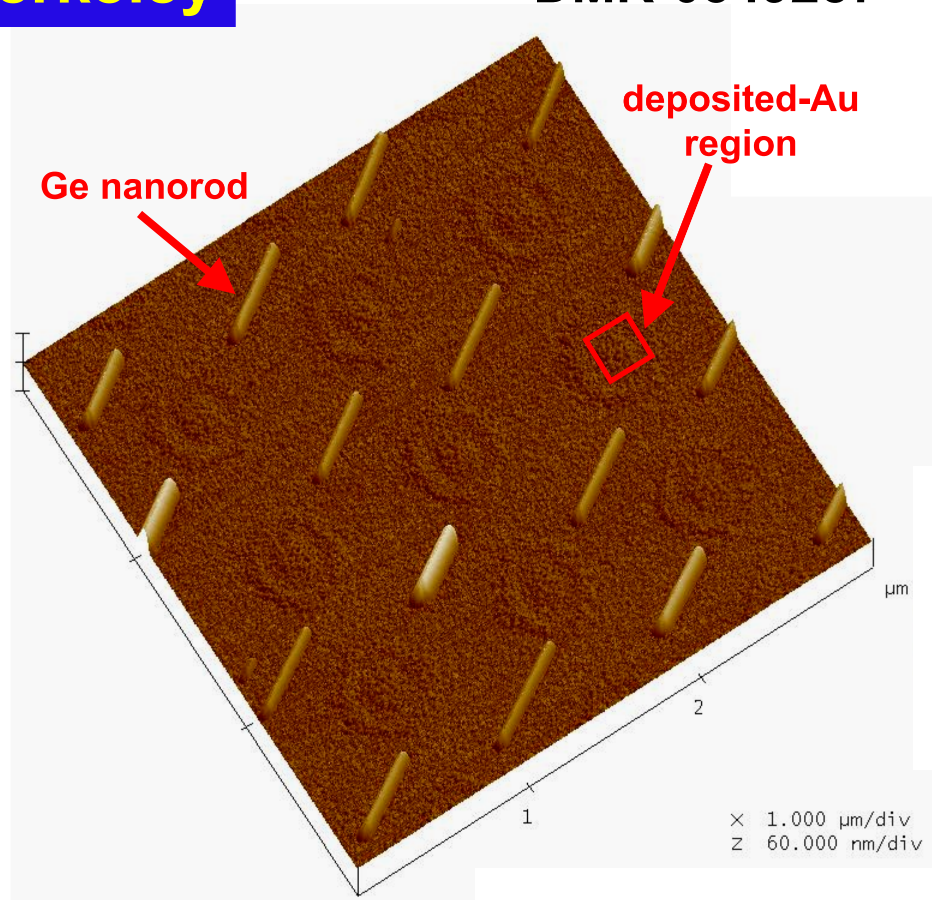
Realizing ensembles of interconnected semiconductor nanostructures of controlled size and arrangement over macroscopic length scales remains one of the great challenges in nanoelectronics. To address this challenge we are undertaking investigations on the use of simple metal-patterning techniques in epitaxial growth to direct the assembly of semiconductor nanostructures. We have recently discovered that the deposition of Ge onto a Au-patterned Si surface results in the formation of Ge islands that organize in response to the Au pattern (figure). Assembly of interconnected nanostructures may be directed by the application of this novel synthesis process to surfaces with predefined electrodes.




AFM image of Ge nanorods grown on Au-patterned Si (110). The nanorod array extends across ~$10^5$ µm$^2$ and is limited only by the size of the reusable stencil mask through which Au is evaporated onto the Si substrate.

We have recently discovered a simple, versatile route for the directed assembly of semiconductor island arrays whereby manipulation of surface kinetics is achieved in a single-step substrate-patterning process.

Gold is evaporated through a stencil mask onto a Si wafer that has been prepared simply by cleaning in solvents and rinsing in hydrofluoric acid. After Au evaporation, the wafer is heated to the growth temperature of 600 °C in an ultrahigh vacuum, thin-film deposition reactor, and Ge is deposited from an effusion cell.

We have achieved two-dimensional alignment of Ge islands grown on Au-patterned Si. Island shape depends on the orientation of the Si substrate. For a (001) orientation, islands are truncated pyramids while growth on a (110) surface leads to nanorods as shown in the slide.

The Ge islands form a square lattice in response to the square array of deposited-Au regions. The island arrays extend over $\sim 10^5\ \mu m^2$, an area limited only by the extent of the Au pattern (i.e., the stencil mask design). The arrangement of islands can be modified by altering the Au pattern. Note that the islands form away from the deposited-Au region! Our studies suggest that a number of surface diffusion process are at work.